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Establishing Links Between U.S. Army Facility Attributes and Mission Requirements

by
William H. Flickinger
Gonzalo Perez
Tanya Lee
Robert D. Neathammer

While Army installation facilities actively help accomplish Army mission requirements, it is sometimes difficult to quantify their contribution. In the climate of shrinking Federal funding, it has become important to present Army facility construction, maintenance, and repair programs in a context that clearly shows their relationship to the overall Army mission, as high-priority tasks. A facility's mission and/or functional responsiveness can be seriously compromised when facility requirements or unit missions are scaled down because the relationship between well-maintained facilities and the Army's "mission readiness" has been downplayed or misunderstood.

This interim report establishes some of the relationships between facility attributes and the Army's mission requirements. A literature search and survey of Army installation commanders showed that a unit's mission readiness is directly related to equipment maintenance and to personnel turnover. Mission readiness is indirectly related to other maintenance and repair functions, and to "quality of life" factors that affect personnel turnover.

Later stages of this research will devise a model to quantify and measure the effects of facility attributes on Army mission requirements to help properly prioritize facility construction, maintenance, and repair projects.

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FOREWORD

This research was performed for the U.S. Army Engineering and Housing Support Center (USAEHSC), Fort Belvoir, VA, under Project 4A162734AT41; Work Unit SA-AP1, "Facility Mission Relation." The USAEHSC technical monitor was Mr. Stewart Grayson, CEHSC-FM-A.

The research was performed by the Facility Systems Division (FS) of the U.S. Army Construction Engineering Research Laboratory (USACERL). The principal investigator was Mr. William H. Flickinger. The following USACERL personnel provided valuable input throughout the preparation of the initial report: Mr. Gonzalo Perez, Ms. Joyce Baird, Mr. Douglas C. Heinen, Ms. Jane L. Solon-Wetmore, Mr. Robert Neathammer, Ms. Tanya Lee, and Mr. Musaab E. At-Taras. Dr. Michael J. O'Connor is Chief, USACERL-FS. The USACERL technical editor was Mr. William J. Wolfe, Information Management Office.

COL Daniel Waldo, Jr., is Commander and Director of USACERL, and Dr. L.R. Shaffer is Technical Director.

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ESTABLISHING LINKS BETWEEN U.S. ARMY FACILITY ATTRIBUTES AND MISSION REQUIREMENTS

1 INTRODUCTION

Background

The Department of the Army (DA) and Headquarters, U.S. Army Corps of Engineers (HQUSACE) recognize that, while Army installation facilities actively help accomplish Army mission requirements, it can sometimes be difficult to quantify their contribution. As a result, when high-level DA decisions are made to support and fund a spectrum of relatively important programs, this perception frustrates the effort to give proper priority to facility construction, maintenance, and repair. As Federal funding programs tighten and the total amount available to programs that support facilities also shrinks, it becomes increasingly important for the DA and HQUSACE to present construction, maintenance, and repair programs in a context that shows their relationship to the overall Army mission, as high-priority DA interests. A facility's mission and/or functional responsiveness can be seriously compromised when facility requirements or unit missions are scaled down because the relationship between well-maintained facilities and the Army's ability to remain "mission ready" has been downplayed or misunderstood. There is a need to clearly establish the relationship between facility attributes and the Army's mission requirements.

Objective

The overall objectives of this project are:

1. To establish the direct and indirect links between installation facilities and the mission readiness/accomplishment of Army units, and to document the relationships between the two
2. To design and conduct experiments to explain the qualitative and quantitative contributions of facilities to Army mission object
3. To develop a knowledge-framework model that uses this data to analyze the facility-mission relationship and to rank facility construction and/or maintenance and repair projects by priority.

The objective of this first portion of the study is to establish the direct and indirect links between installation facilities' attributes and the readiness/accomplishment of Army units.

Approach

In this stage of research, the U.S. Army Construction Engineering Research Laboratory (USACERL) conducted a literature search including, but not limited to, studies done by the following organizations: USACERL, the Army Research Institute (ARI), the Rand Corp., the Walter Reed Army Institute of Research (WRAIR), the Naval Postgraduate School, and the Army War College. The search reviewed similar studies done to determine the direct and indirect relationships between facilities and mission. A

survey (Appendix A) was written jointly by USACERL and Massachusetts Institute of Technology (MIT) personnel, and was sent to Installation Commanders to gain insight into important installation-level concerns, and to gather data needed to develop an econometric model to help decisions to repair, renovate, or tear down and rebuild deteriorating facilities.

This information will augment later work that will quantify facility contribution to its mission by facility or facility grouping, for example, by maintenance facilities. Each facility or facility grouping will be weighted in degrees of importance by its relative contribution to the mission and by other demands. The relationship of the facility to the mission of the facility owner will be measured against factors such as unit readiness, morale and welfare, vehicle and weapon upgrading, and other criteria.

A model will be developed that uses these weighted factors to measure a facility's physical and psychological effects on the mission, and to document how well the facility supports mission requirements. By setting the variables and ranking factors, the model will then compare an installation's available assets with those required to meet its mission, and will rank deficiencies in order of greatest need.

Scope

Not all links are identified at this stage of research. The major areas considered were limited to the relationships between:

1. Facility attributes and installation command objectives
2. Facility attributes and installation investment strategies
3. Human occupants and the facility
4. Facility condition and the mission.

Mode of Technology Transfer

It is anticipated that a formal technical transfer plan, to be developed in FY93, will incorporate the results of this literature search into existing standard operating programs such as the Unit Status Report. This incorporation would impact Army Regulation (AR) 200-1, *Unit Status Reporting* (Headquarters, Department of the Army [HQDA], 16 September 1986).

2 RESEARCH FOCUS

Direction

Facility maintenance activities are vital to Army management. Stiff competition for scarce Defense funds to support the entire Real Property program (planning, programming, designing, constructing, revitalization, operating, and maintaining functions) can make it difficult to do needed maintenance. There are many regulations and much guidance to help track the resultant backlog of maintenance and repair activities. In fact, the whole area has become a major concern. These regulations and other guidance are regularly updated and reviewed at the installation level to keep the proper emphasis on maintenance and repair activities. Still, the Army and Department of Defense have had limited success in gaining the funding necessary to keep facilities in good condition. There is a need to balance the requirements of the Army infrastructure against the expense of revitalizing it, and at the same time to keep that infrastructure in satisfactory condition by construction, maintenance, and repair.

The primary motivation for funding the Department of Defense is to ensure that the United States can defend its way of life, both domestically and internationally. A strong, "mission ready" U.S. military is a positive influence for world peace. Mission readiness translates to the actual units that are trained and capable of performing their missions in any contingency operation. Funding is allocated for equipment, weapons and weapons systems, personnel, training, and all the logistics necessary to keep the services a viable force.

In a sense, maintaining a strong military force is similar to operating any business with a defined purpose. Any successful business (including the Army) must account for its costs. Army costs must be traced to a product that visibly contributes to mission requirements. The costs of equipment, weapons and weapons systems, personnel, training, and other "concrete" activities are measured and evaluated as part of an audit trail that can be used to justify that funding. The "bottom line" demands a clear accounting for the costs of each product, and for how that product contributes to mission readiness.

Maintenance and repair activities are not always clearly defined in terms of "mission readiness." Many maintenance costs are invisible. In his 1988 Master's Thesis, Lieutenant Thomas S. Hollinberger, Civil Engineer Corps, U.S. Navy states:

The facility maintenance function has a supporting role, as opposed to a line function, in most businesses. As such, facility maintenance is often a weak competitor for limited resources, since the functions that contribute directly to a company's bottom-line, such as production of sales, have a more immediate claim on resources.¹

In his opening discussion, he further states that:

Another roadblock to quantitative justification of facility maintenance budgets is the necessity for accounting systems to keep a stable chart of accounts over the years. This necessity, coupled with the tendency for output measurement emphases, produces a common disparity. That is, management needs to evaluate output . . . to make management, control, budgetary, and policy decisions. However, when attempting to compare output to the resources that produce the output, often the accounting system does

¹ Thomas S. Hollinberger, *Maintenance and Repair of Naval Shore Facilities: Resources and Readiness*, ADB130098L (Naval Postgraduate School, Monterey, CA, December 1988).

not track costs by output categories. Instead, the accounting system is adequate for comparing expenses from year to year in accounts that reflect areas and categories of concern at the time the accounting system was built and, in most instances have not changed much since. The result is an unpleasant choice of comparability over several years on one hand, and visibility of current areas of concern on the other, i.e., outputs cannot readily be traced back to resource inputs and changes in inputs.

The facilities maintenance function . . . faces such problems. Accounting systems cannot describe resources spent by mission areas . . . where the right amount may be related to mission areas, it is often not possible to show the effect of resources on readiness (bottom-line output).²

Though LT Hollinberger was arguing the case for the Navy, the thesis applies to the Army as well as the other armed services. This research evaluates the impact of facilities on mission accomplishment and unit readiness. In other words, if funds for construction and Operations and Maintenance (O&M) are cut, the results of this study will evaluate how much mission accomplishment and unit readiness will be reduced.

The Base Structure Report for Fiscal Year 1989 states that:

Military installations are vital to the nation's security, and quality facilities greatly enhance the working and living conditions of our military people and their families. . . . The worldwide military base structure supports our defense population. . . . The investment that this country makes in its defense facilities is an investment in its military people—an investment that is repaid in the form of improved pride, greater performance, and better combat readiness.³

The report further states that, "All base operating support, either directly or indirectly, contributes to the performance of the military mission."⁴ This report establishes the relationship that must be defined and quantified to develop usable tools for HQUSACE, Office of the Chief of Engineers (OCE), Major Army Commands (MACOMs) and others to defend the entire Real Property program (planning, programming, designing, constructing, operating and maintaining functions) at the DA staff level and higher. Figure 1 shows the complex relationships that need to be clarified.

In its overview of Army base structure, the Base Structure Report for Fiscal Year 1989 describes the Army's mission to organize, train, and equip for prompt and sustained combat coincident with operations for effective prosecution of the war.⁵ The report points out that the Army supported that mission from a fixed base structure: "The Army is basically tied to its existing installations to support its current force structure."⁶ Due to the aging base structure and constrained land assets, the Army has defined a base structure policy of maintaining the current facilities, correcting deficiencies, and replacing or renovating the deteriorated facilities to provide the best mix of maintenance, construction, and renewal.⁷ Given the present policy of maintaining existing facilities, and the recent demonstration of how this fixed base structure successfully supported the mission in the Persian Gulf, it is apparent that adequate facilities maintenance is directly linked to the Army's overall mission.

² Thomas S. Hollinberger, p 1.

³ Base Structure Report for Fiscal Year 1989 (Office of the Assistant Secretary of Defense, Production and Logistics, March 1988), p 1.

⁴ Base Structure Report for Fiscal Year 1989, p 3.

⁵ Base Structure Report for Fiscal Year 1989, p 13.

⁶ Base Structure Report for Fiscal Year 1989, p 14.

⁷ Base Structure Report for Fiscal Year 1989, p 14.

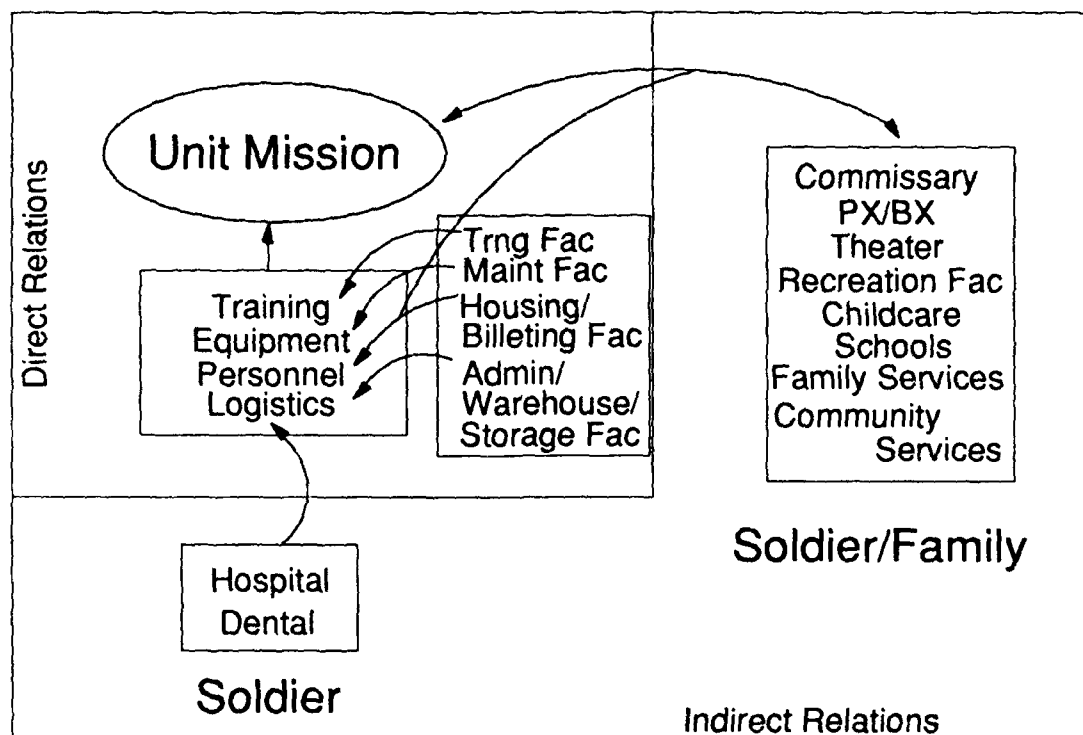


Figure 1. Facility/Mission Relationships.

Historical Records

Various records show a unit's readiness and ability to complete mission requirements, including the Annual General Inspection (AGI) Reports, the Army Training and Evaluation Program (ARTEP), and the Unit Status Report (USR). The AGI report evaluates the unit's records, personnel, logistics, maintenance, and so on to provide a "snapshot" of the unit. This report indicates to the commander if the unit can perform its assigned mission based on standards set by the DA. The ARTEP is an annual training and evaluation program that prescribes the unit mission and those collective tasks which the unit must do, "not only to survive on the battlefield, but to win the battle."⁸ The ARTEP links mission readiness to the quality of training the unit has received. This link includes the size and number of training facilities. The USR is a monthly report, summarized quarterly and annually. It gives a continuous record of the status of vehicles, equipment, logistics, and personnel that affects the units' mission readiness.

ARTEP information may have limited application to a facility-level evaluation. The literature indicates that ARTEP records have been studied to determine the level of readiness and training within individual units. There was no significant finding that expanded on the ARTEP results related to facilities. As a sidelight, a significant number of articles did link personnel turbulence (turnover) to mission

⁸ *Engineer Equipment Companies*, ARTEP 5-54 (Headquarters, Department of the Army [HQDA], 17 May 1983), p 1-1.

readiness: "The ARTEP evaluation loses its validity too quickly to be of use in the planning function because of personnel turbulence."⁹

Another point that was brought out in the study on ARTEP's was maintaining unit readiness. For a unit to be fully mission capable, it must be able to function as an effective force in all its assigned missions. An ARTEP measures the level of proficiency at one point in time for the particular skills being evaluated. However, the unit must continue to train at a higher level and develop into a more mature organization to be an effective force. "If a unit's ARTEP evaluation is invalid because of personnel turbulence, then the unit must begin training at the very basic level before it can move on to larger unit or more specialized training"¹⁰ This means that units declared mission ready must advance in their level of proficiency. Facility attributes that contribute to this mission readiness are of interest in this research. These facilities may be both directly and indirectly related to mission readiness. Overall, ARTEP evaluations reinforce this observation:

There is a positive relationship between personnel turbulence and the validity of the ARTEP evaluation. The evaluation is only valid as long as the unit retains [the] preponderance of personnel that participated in the evaluation. When a unit experiences a high rate of personnel turbulence because it loses its personnel in transfers to other unit or reassignments within the unit, the validity of the evaluation is reduced. It has been assumed that a unit which successfully passes an ARTEP evaluation will also perform well in combat.¹¹

ARTEP evaluations underscore the importance of establishing the link between facilities and their effect on the soldier, as an indirect link between the facilities and the mission. Captain David L. Bland, USAF, in his 1990 thesis, highlighted the importance of personnel retention. He noted insights gained from Captain Terry D. Kline's 1988 thesis:

In this day of reduced military budgets, the DoD must be more concerned with saving precious defense dollars. The retention of trained and experienced personnel is one of the possible areas of such savings . . . about 42 percent of the defense budget goes for manpower needs. A goodly portion is spent on the recruiting, training, and retraining of personnel. While some recruiting, training, and retraining will always be required, the military services must strive to maintain the proper balance between accessions of new personnel and retention of trained and/or fully qualified personnel.¹²

This is discussed in more depth in the section on "Quality of Life." (p 12)

Maintenance of Equipment

Army manuals cover prescribed maintenance and repair of weapons, vehicles, aircraft—virtually any equipment assigned to a unit. It is feasible to develop a database for specific Table of Organization and Equipment (TO&E) units and the facilities required to support that TO&E. Data analysis may show whether existing facilities are adequate to meet mission requirements, that is, to determine if facilities are "mission ready." (The same database can be used to recommend facility closure of excess facilities.) The

⁹ James A. Amendolia, *Training Management and Personnel Turbulence*, ADB059955L (Army Command and General Staff College, Fort Leavenworth, KS, June 1981).

¹⁰ Amendolia, p 74.

¹¹ Amendolia, p 75.

¹² David L. Bland, *An Analysis of the Effects Housing Improvements Have on the Retention of Air Force Personnel*, AFIT/GEM/DEM/90S-2/ADA229466 (Air Force Institute of Technology, Wright-Patterson AFB, OH, September 1990), p 18.

relationship between the quantity of facilities and assigned unit equipment can directly link facilities to mission readiness. The quality of those facilities indirectly links facilities to their missions.

The hypothesis, as applied to this portion of the project, is that mission readiness can be measured by how well each piece of equipment in the inventory has been maintained, by whether its maintenance schedule has been kept up. These schedules apply to everything from the primary weapons system such as a tank in an Armor unit, to supply issue items such as blankets, boots, and helmets. By applying this information to the total number of items requiring service and/or maintenance, the facilities required to perform those services and/or maintenance, and then by developing a schedule that reflects the demand on those facilities, a direct connection can be drawn between a facility and its mission requirement. By factoring in unscheduled repairs, predicting backlog on services and maintenance, and their effects, it is possible to project the future "availability" of needed equipment (in weeks, months, or years). Consequently, a facility incapable of maintaining its equipment cannot be considered "mission ready."

The description above expands on an obvious relationship between the facility and the mission: that certain facilities must be available to support the weapons and other equipment in the modern Army's inventory. A less obvious relation exists between the deterioration of a facility and its mission readiness. This important aspect is explored separately in the following section. The DIVISION 86 study briefly discussed facility upgrades, an aspect summarized in the section, "Commander Input." (p 14)

Repair and Maintenance of a Facility or Build New

This work will relate general facility requirements to TO&E, and will focus on historical impact. The relationship of the facility to the mission will determine whether to repair, renovate, or tear down and rebuild deteriorating facilities. Analysis methods will include *Econometric Modeling* using statistical and time-series analysis. The statistical analysis will use both analysis of variance and regression analysis. Time-series analysis will employ a multivariate, auto-regressive integrated moving average (ARIMA).

Facilities become critical when new equipment is fielded. For example, during the DIVISION 86^{*} period of force modernization, a Facility Support Plan (FSP) for the fielding of the Field Artillery Battalion, 8-in. Self Propelled/Multiple Launch Rocket System was generated that affected DA Pamphlet 5-25.¹³ As is typical when fielding new equipment or restructuring the Army to meet a current threat, a list of the facility requirements were identified, including both "organic" and "non-organic" facilities:

Organic facilities are those facilities normally allocated to a military unit by virtue of its mission and operational requirements.¹⁴

Non-organic facilities are those facilities normally provided by other military units or installation activities necessary to support the mission of the units.¹⁵

This will be covered in more detail in the final report (FY94).

^{*} DIVISION 86 was an Army-wide modernization program begun in 1981.

¹³ *DIVISION 86 Field Artillery Battalion 8-Inch Self Propelled/ Multiple Launch Rocket System, Army Force Modernization Facility Support Plan*, OCE-FSP-83-032/ADB073341L (Office of the Chief of Engineers [OCE], February 1983); DA PAM 5-25, *Army Modernization Information Memorandum (AMIM)* (HQDA, 1990).

¹⁴ *Army Force Modernization Facility Support Plan*, p 5.

¹⁵ *Army Force Modernization Facility Support Plan*, p 7.

Human/Facility Interior Interaction

"Interior Interaction," or how well a facility's design meets its occupants' needs or comforts, is not critical to this particular project; however, interior interaction does play a role in personnel performance, which in turn relates to a facility's contribution to overall mission performance. Because its role is remote, interior interaction will only be given a superficial review in this study.

Current investigations¹⁶ of human/facility interior interaction and facility usage requirements focus on improving the facility "delivery process," that "cradle-to-grave" planning for facilities: from concept, through construction, to occupancy and eventual disposal. This research analyzes the programming, design, planning, criteria, and any other pertinent areas that best represent the facility requirements. Some of the investigations go further by looking at the programming, planning, and design having the best life cycle capability. That is to say, an individual facility (an office building, for example) is likely to be used for several distinct purposes throughout its useful life; its initial design should be flexible enough to meet changing requirements. Consideration of the flexibility and ability to modify a facility or its interior space is also covered. Significant to this study are those attributes that affect morale and satisfaction with the work environment, and how those attributes contribute to mission readiness.

As yet there is no way to measure the relationship between Army missions, facility requirements to accomplish those missions, and human welfare, satisfaction, and work performance within those facilities. This research will address the interrelationship between human welfare and satisfaction, and the physical attributes of a facility. Results of this effort will provide the implied indirect links between the facility and mission readiness. As will be discussed in the following section, the morale and welfare of the soldier is important in an overall assessment of readiness. Facilities affect the individual soldier's as well as the unit's ability to perform the mission. A necessary and separate area of study is how a facility's use of space and of its physical surroundings (facility/environment) affect mission readiness.

Quality of Life

Over the years, studies such as those cited in this section have investigated the relation between military installations and the requirements of maintaining a standing Army. Past programs such as "Communities of Excellence," "Year of the Soldier," etc., depended on the positive impact these programs had as an "indirect" force multiplier. Studies conducted in the early 1970s on the transition from a "Draft" Army to a Volunteer Army (VOLAR) and attrition may help connect retention and mission readiness to quality of life issues. The emphasis that has already been placed on quality of life and concern for the appearance of the military communities does indicate a strong basis for linking mission readiness with an installation's facilities. For example, the Army Communities of Excellence (ACOE) described in DA PAM 600-45 makes direct references to the quality of the facility and mission performance:

¹⁶ Douglas C. Heinen et al., *Human/Facility Interior Interaction*, Concept Draft developed under the current work unit SA-X02, "Human/Facility/Mission Interaction," of Project 4A161102AT23, "Basic Research in Military Construction" (USACERL, 6 August 1991).

Excellent facilities constitute the physical environment in which services are performed and in which activities take place. Excellent facilities are force multipliers. . . . Traditionally, we have set our sights far too low; we have not realized the impact facilities have on our people.¹⁷

The quality of life issue appears to be significant. Since the ARTEP results show a direct relationship between mission readiness and personnel turnover, it also becomes necessary to understand the indirect relationship between facilities and mission readiness based on the facilities' affects on the soldier. Assistant Secretary of Defense (Force Management and Personnel) Chapman B. Cox has stated that concern for the quality of life of DOD employees pays off in retention, better morale and increased productivity.¹⁸ Mr. Robert P. Stone, as Deputy Assistant to Secretary of Defense (Installations), has emphasized that quality of life is affected by the facilities in which the military personnel live and work:

Facility investment is critical, we can't afford not to invest more. Obsolete facilities are expensive because they cost us productivity, quality, and pride—which means reduced mission capability. Industry invests about three times as much, proportionally, as DOD. Major companies . . . invest in quality facilities to get and keep the best people, to get the best from their people, and to accomplish their mission better. . . . These companies know that quality facilities repay their cost in the quality of work done by people who use them.¹⁹

More specifically, a 1988 thesis entitled *An Analysis of Quit/Stay Decisions of Junior Army Officers* states that, "satisfaction with medical facilities, . . . recreation services, . . . commissary facilities, . . . and a good environment for the family . . . lead to increase in satisfaction with the military life."²⁰

An installation supports more than the unit and the mission of that installation. The facilities must perform supporting, functional roles that include secondary, "implied" missions. While the primary emphasis is to support the mission of the assigned unit, the secondary mission is to support the soldiers and their families: "The installation is a living/working community of soldiers and their families. As research during the past two decades has shown us, the phrase 'and their families' is increasingly important."²¹

Entries in the DD 1391, section 11, "Impact if not provided" commonly express a similar concern: "If this project is not provided, the lack of adequate childcare at Fort Myer will adversely affect mission readiness, retention, and service member morale."²²

¹⁷ DA PAM 600-45, *Guidelines for Community Excellence* (HQDA, October 1989), ch. 3-1, p 7.

¹⁸ Terry D. Kline, *An Investigation Into the Predictors of Employment Intentions for Department of Defense Employees*, MS Thesis, AFIT/GSM/LSR/885-14/ADA201493 (School of Systems and Logistics, Air Force Institute of Technology, September 1988).

¹⁹ Robert P. Stone, "'Excellent Installations', 1989 Annual Report of the Deputy Assistant Secretary of Defense (Installations)," *Defense Housing* (November-December 1989), Vol III, No. 6, pp 18-20.

²⁰ Rashmi Lal, *A Model of Employment Decision Making: An Analysis of Quit/Stay Decisions of Junior Army Officers*, ADA204414 (Engineering and Economics Research Inc., Reston VA, April 1988), p 22.

²¹ David A. Blankinship, *The Role of Installation Leaders in Creating a Supportive Family Environment*, Report No. 1558/ADA223799 (Research Triangle Institute, Research Triangle Park, NC, May 1990).

²² "Department of the Army Justification of Estimates for FY91 Submitted to Congress January 1990," ADA221870, *Operation and Maintenance, Army Justification Book* (Washington, DC, 1990), Vol 3, p 342.

On this same note, a recent Garrison Commanders' Survey²³ conducted by the Director of Management at the Army Chief of Staff level (DACS-DME) cited that the most significant mobilization problem is single-parent assistance.

A significant amount of the literature discussed effects of "quality of life" issues to mission readiness. As mentioned earlier, historical records lose their usefulness if the unit they measured experiences a high personnel turnover. For instance, the ARTEP cited earlier indicated that reduced personnel turnover, outside of normal duty rotation, could extend the validity of the ARTEP. Factors that help stabilize soldiers and reduce turnover are the "quality of life" issues such as housing, childcare services and facilities, and other community services and facilities.

Discussion of direct links between facilities and their contribution to mission readiness must include the effects of indirect factors. The indirect links are the quality of the facilities, the equipment, and the working personnel and how that quality affects performance, in other words, how it affects mission readiness. Inadequate or inferior facilities affect the soldier's morale and desire to work, thus reducing productive time. Two entries in the DD 1391 section "Impact if not provided" highlight this point:

If this project is not provided, adequate and necessary recreational facilities will continue to be unavailable to basic trainees and service enlisted personnel. There are no other facilities available that can be used for recreation. Without a break from the hard grind of training, the morale and performance of new recruits could suffer.²⁴

and,

If this project is not provided, aviation training will continue to be hampered by limited resources, safety and environmental constraints, and rising costs. The new trainer cannot be delivered until the proposed building has been completed. Only limited training will be accomplished without the AVCATT, it will be expensive in terms of all resources required, e.g., costs, training area usage, aircraft, and pilots.²⁵

While the quality of the equipment soldiers use and train with also affects personnel retention, and in turn affects the unit's readiness, investigation of the quality of equipment is beyond the scope of this study.

Commander Input

Several installation Commanders were surveyed to identify perceived relationships between Commander objectives and facility characteristics. The data taken from this survey will be analyzed to determine, from the Commander's point of view, which facilities are relatively important to mission readiness. The Commander must assume that his unit can perform its mission. Additionally, a copy of the survey conducted by the Director of Management within the Army Chief of Staff was reviewed. The focus of the survey sent out by DACS-DME was to solicit the Garrison Commanders' concerns.

²³ *Garrison Commanders' Survey Summary Report* (Department of the Army Chief of Staff, Installation Management Division, 29 November 1990).

²⁴ *FY 1991 Budget Estimates: Military Construction, Family Housing, and Homeowners Assistance* (Department of the Army [DA], 1990).

²⁵ *Department of the Army Justification*, p 22.

In that survey the respondents were almost unanimous in stating that the most significant change facing commanders is maintaining aging facility infrastructure. Declining resources is the second most significant problem. The commanders noted that as Base Operations (BASOPS) resources continue to decline, the potential future cost to facilities will be paramount. Garrison Commanders recognize dwindling resources and aging facilities as inherent problems, something which came as no surprise to the Director of Management at the Army Staff.²⁶

Military Construction Project Data

Every year, the Department of Defense presents its budget to Congress for approval and funding. The Army portion of that budget is partially fed by the "Green Book,"²⁷ which consists of all Major Construction, Army (MCA) projects requiring funding approval. This information comes from the DD Form 1391. The Automated DD Form 1391 Processor System (1391 Processor) helps MACOMs, Installations, and Headquarters, Department of the Army (HQDA) develop, submit, review, edit, prioritize, and approve DD Forms 1391 Military Construction Project Data. At Army installations, projects are developed, prioritized, and submitted electronically to Major Sub-commands and MACOMs, where they are reviewed, edited, prioritized and resubmitted electronically to the DA Program Manager. U.S. Army, Corps of Engineers (USACE) Districts and Divisions participate in the development/review process and receive the 1391 documents as primary descriptions of projects to be designed. DD 1391s are the principal statutory instruments for the Authorization and Appropriation of Military Construction. The *President's Budget to Congress for Military Construction* is composed largely of these documents. Once enacted into law, they become the governing documents for Construction control.

Paragraph 11 of the DD 1391 requires the preparer to indicate the "Impact if not provided." A sampling of DD 1391's submitted to Congress for Military Construction for FY 1991²⁸ produced the following entries. (Full text and content are provided in Appendix A):

If this project is not provided, the 87th Engineer Company will not have an adequate and functional facility to perform maintenance and repair to their vehicles and will not be able to effectively perform their mission in support of the NTC.

If this project is not provided, aviation training will continue to be hampered by limited resources, safety and environmental constraints, and rising costs.

If this project is not provided, inadequate production now available cannot maintain current stockage levels. Existing stocks will exceed useful shelf life without replacement. Unavailability of detection paper will increase vulnerability of soldiers to chemical attack, with potential significant increase in numbers and severity of chemical casualties thus affecting mission accomplishment.

The President's budget to Congress for Military Construction serves as a testimony to the relationship between the facility and the mission it supports. In the budget, the justifications for the funding requests are found in the Green Book. In most cases, the failure to support the facility has direct or indirect impact on the mission readiness of a unit, and in most cases, support of the facilities is expressed in support for their construction, maintenance, and repair programs.

²⁶ Garrison Commanders' Survey Summary Report.

²⁷ The "Green Book," or the *Authorization and Appropriation of Military Construction*, is a yearly budget document used to develop the *President's Budget to Congress for Military Construction*.

²⁸ *Department of the Army Justification*, various.

3 CONCLUSIONS

This research has established some of the direct and indirect links between an Army installation's facilities and its mission readiness/accomplishment. It is concluded that the following relationships exist:

1. An indirect relationship exists between maintenance and repair activities and mission readiness. The present policy of maintaining existing facilities, along with the successful demonstration of how this fixed base structure supported the Army's mission in the recent Persian Gulf War, clearly show that adequate facilities maintenance is linked to the Army's overall mission.

2. A direct relationship exists between personnel turbulence (turnover) and mission readiness. A Review of the Army Training and Evaluation Program (ARTEP) records, which are studied to determine levels of readiness and training, indicates that there is a positive relation between ARTEP evaluations and personnel turbulence.

3. Factors that influence personnel turnover have an indirect relationship with mission readiness. These are "quality of life" factors, which often involve construction and maintenance of those services and facilities where military personnel live and work: housing, the workplace, childcare services and facilities, and other community services and facilities.

4. A direct relationship can be established between equipment maintenance and repair, and mission readiness. This relationship can be documented by developing a database for specific Table of Organization and Equipment units. By tracking required maintenance schedules against actual records, and factoring in unscheduled repairs, predicting backlogs on services and maintenance, and their effects, it is possible to show whether existing facilities are adequate to meet their stated mission requirements.

It was noted that not all the studies performed on this subject exist in published form. Efforts continue to locate unpublished investigations on this topic. Work also continues in analyzing data from surveys sent to Installation Commanders and in collecting data for the development of an econometric model. This model will become one of the tools needed to quantify and measure these relationships.

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LIST OF ABBREVIATIONS

ACOE	Army Communities of Excellence
AI	Artificial Intelligence
AGI	Annual General Inspection
AMIM	Army Modernization Information Memorandum
ARI	Army Research Institute
ARIMA	Auto Regressive Integrated Moving Average
ARTEP	Army Readiness Testing and Evaluation Program

LIST OF ABBREVIATIONS (Cont'd)

BASOPS	Base Operations
DA	Department of the Army
DD	Department of Defense (abbreviation for forms); see also DoD
DoD, DOD	Department of Defense
FS	Facility Systems
FSP	Facility Support Plan
FY	Fiscal Year
HQDA	Headquarters, Department of the Army
HQSACE	Headquarters, U.S. Army Corps of Engineers
MACOMS	Major Army Commands
MADS	Mission Area Deficiency Statement
MCA	Major Construction, Army
NTC	National Training Center
OACE	Office of the Chief of Engineers
O&M	Operations and Maintenance
PAM	Pamphlet
PI	Principle Investigator
RPMA	Real Property Maintenance Activities
TO&E	Table of Organization and Equipment
USACE	U.S. Army Corps of Engineers
USACERL	U.S. Army Construction Engineering Research Laboratory
USAEHSC	U.S. Army Engineering and Housing Support Center
USR	Unit Status Report
WRAIR	Walter Reed Army Institute of Research

APPENDIX A: Survey of Installation Commanders

Survey of Installation Commanders

Identifying the Relationship Between Commander Objectives
and Facility Characteristics

U.S. Army Corps of Engineers
Construction Engineering Research Laboratory
and
Massachusetts Institute of Technology

INTRODUCTION

The relationship between commander objectives (*i.e., readiness, quality of life, retention*) and facility characteristics (*i.e., facility type, quantity/amount, physical condition*) is not well understood. There is no system for comparing the achievement of commander objectives under different facility strategies. The purpose of this questionnaire is to define the relationship between commander objectives and facility characteristics in a form that can be used in the development of practical decision support tools. Ultimately, these tools will provide the capability to predict the impact of facility management decisions on the achievement of commander objectives.

This questionnaire is directed solely towards installation commanders. It is their experience and opinions that will make the results valid and useful. The Director of Engineering and Housing will be receiving a similar questionnaire.

All responses will be handled in a confidential manner. No names of individual respondents or installations will be used in the presentation of results.

Name: _____

Rank: _____

Installation: _____

Location: _____

POINT OF CONTACT

For additional information about this study or any specific questions concerning this survey, please contact Ms. Joyce Baird, U.S. Army Construction Engineering Research Laboratory, 1-800-USA-CERL.

1. Given your installation's mission, rate the following types of **OBJECTIVES** in terms of their importance to you as an installation commander. (Please circle the appropriate number for each item)

OBJECTIVES	Less Important				More Important
Readiness	1	2	3	4	5
Training	1	2	3	4	5
Productivity	1	2	3	4	5
Quality of Life	1	2	3	4	5
Retention	1	2	3	4	5
Awards Programs	1	2	3	4	5
Statutory Compliance	1	2	3	4	5
Force Modernization	1	2	3	4	5
Profitability (i.e., self-supporting MWR facilities)	1	2	3	4	5
Other _____ (please specify)	1	2	3	4	5
Other _____ (please specify)	1	2	3	4	5

2. Given your installation's mission, rate the importance of the following types of **MEANS** in achieving your overall **OBJECTIVES** as an installation commander. (Please circle the appropriate number for each item)

MEANS	Less Important				More Important
Land	1	2	3	4	5
Facilities	1	2	3	4	5
Equipment	1	2	3	4	5
Personnel	1	2	3	4	5
Funding	1	2	3	4	5
Other _____ (please specify)	1	2	3	4	5
Other _____ (please specify)	1	2	3	4	5

3. Given your installation's mission, rate the importance of the following **ORGANIZATIONAL ELEMENTS** in achieving your overall **OBJECTIVES** as an installation commander. (Please circle the appropriate number for each item)

ORGANIZATIONAL ELEMENTS	Less Important				More Important
Headquarters Command (HQ CMD)	1	2	3	4	5
Major Subordinate Commanders	1	2	3	4	5
Resource Management (DRM)	1	2	3	4	5
Engineering & Housing (DEH)	1	2	3	4	5
Personnel & Community Activities (DPCA)	1	2	3	4	5
Plans, Training, & Mobilization (DPTM)	1	2	3	4	5
Security (DSEC)	1	2	3	4	5
Logistics (DOL)	1	2	3	4	5
Provost Marshal's Office (PMO)	1	2	3	4	5
Information Management (DOIM)	1	2	3	4	5
Reserve Component Support (DRCS)	1	2	3	4	5
Contracting (DOC)	1	2	3	4	5
Other _____ (please specify)	1	2	3	4	5
Other _____ (please specify)	1	2	3	4	5

INSTRUCTIONS FOR QUESTIONS 4A, 4B & 4C

Based on your current installation command, fill in your first, second, and third most important **OBJECTIVES** in the appropriately marked red boxes in questions 4A, 4B and 4C, respectively. See example. *A list of possible commander objectives can be referenced in question 1, but please feel free to fill in different objectives using your own terminology.*

In achieving each of these three **OBJECTIVES**, identify the 1st, 2nd, and 3rd most important **FACILITY TYPES** available to you as an installation commander. Three responses are required in each blue column in questions 4A, 4B and 4C. See example. *For further explanation of any one facility type please refer to the inside back cover page.*


Note that each facility type in questions 4A, 4B and 4C has a corresponding yellow row of facility characteristics. Please identify the 1st, 2nd, and 3rd most important **CHARACTERISTICS** of each of the three **FACILITY TYPES** you identified in each question. A total of nine responses are required for this part of each question, three per facility type. See example. *For further explanation of any one characteristic please refer to the inside back cover page.*

EXAMPLE: The following example indicates that "Readiness" is currently your most important objective as an installation commander. You believe that "Classroom Facilities" is your most important facility type for achieving "Readiness" at your installation, with "Ranges & Training Grounds" and "Administrative Facilities" being your 2nd and 3rd most important facility types, respectively. In your evaluation of how "Classroom Facilities" help you achieve "Readiness" at your installation, you believe that it is most important to have an adequate "Amount" of "Classroom Facilities," it is 2nd most important to have them in good "Physical Condition," and it is 3rd most important for them to "Function Adequately." The same principal applies for the characteristics that are specified for "Ranges & Training Grounds" and "Administrative Facilities."


(EXAMPLE) FIRST OBJECTIVE

		FACILITY CHARACTERISTICS				
		Quantity/ Amount	Functional Adequacy	Physical Condition	Manage- ability	Flexibility
	Ranges & Training Grounds	2	1			3
	Classroom Facilities	1	2	2		
	Maintenance Facilities					
	Medical Facilities					
	Administrative Facilities		3	1	2	

4A. FIRST OBJECTIVE

		Quantity/ Amount	Functional Adequacy	Physical Condition	Manage- ability	Flexibility	Appearance	Location/ Proximity
	Ranges & Training Grounds							
	Classroom Facilities							
	Maintenance Facilities							
	Medical Facilities							
	Administrative Facilities							
	Operational Facilities							
	Storage Facilities							
	Utility Systems							
	M. W. R. Facilities							
	Family Housing							
	Other Housing							
R & D Facilities								

4B. SECOND OBJECTIVE

		Quantity/ Amount	Functional Adequacy	Physical Condition	Manage- ability	Flexibility	Appearance	Location/ Proximity
	Ranges & Training Grounds							
	Classroom Facilities							
	Maintenance Facilities							
	Medical Facilities							
	Administrative Facilities							
	Operational Facilities							
	Storage Facilities							
	Utility Systems							
	M. W. R. Facilities							
	Family Housing							
	Other Housing							
R & D Facilities								

4C. THIRD OBJECTIVE

		Quantity/ Amount	Functional Adequacy	Physical Condition	Manage- ability	Flexibility	Appearance	Location/ Proximity
	Ranges & Training Grounds							
	Classroom Facilities							
	Maintenance Facilities							
	Medical Facilities							
	Administrative Facilities							
	Operational Facilities							
	Storage Facilities							
	Utility Systems							
	M. W. R. Facilities							
	Family Housing							
	Other Housing							
	R & D Facilities							

5. Please evaluate the following statements:

(Please circle the appropriate number for each statement)

	Strongly Disagree	Mostly Disagree	Neutral	Mostly Agree	Strongly Agree
a. Real property decision making, on average, plays a critical part in the overall performance of my installation.	1	2	3	4	5
b. I do not have sufficient information or methodology available to clearly evaluate the physical performance or use effectiveness of my installation facilities.	1	2	3	4	5
c. The "time horizon" or planning period that I typically base my objectives on is defined by my tenure as installation commander.	1	2	3	4	5
d. My installation's investment in such facilities oriented programs as "Communities of Excellence" is having a strong positive impact on the achievement of my overall objectives as commander.	1	2	3	4	5
e. Many of the regulations that are in place are hindering me from making better facility related decisions (i.e., RPMF).	1	2	3	4	5
f. The method by which new construction projects are prioritized at my installation can be improved upon to better support my objectives.	1	2	3	4	5
g. I am provided adequate information for assessing the impacts of funding recommendations made by the Program and Budget Advisory Committee (PBAC Process).	1	2	3	4	5

Thank you for completing this survey. We would welcome any additional comments that you feel might be useful to this study.

If you would be willing to answer additional questions, please provide your telephone number _____
 All respondents will be sent a copy of the results of this survey for their reference.

REFERENCE OF FACILITY TYPES

- CLASSROOM FACILITIES:** (171 Series Category Code) Classroom and other special buildings in which instruction is given, or the design of which limits their use generally to instructional and training purposes. **EXAMPLES:** Battalion Classrooms, Flight Simulator Building, Covered Training Area, Applied Instructional Building, and Post Signal School.
- RANGES & TRAINING GROUNDS:** (179 Series Category Code) Training courses, ranges, maneuver areas, including training mockups, and similar type facilities provided for or limited in use to training. **EXAMPLES:** Field Firing Range, Impact Area, Hand to Hand Combat Pit, Confidence Course, and Parade and Drill Field.
- MAINTENANCE FACILITIES:** (210-218 Series Category Code) Facilities and shops in support of the maintenance repair operation function at military installations. **EXAMPLES:** Aircraft Component Maintenance Shops, Vehicle Maintenance Shop, Small Arms Repair Shop, Electronics and Electrical Maintenance Shop, Vehicle Wash Shop.
- MEDICAL FACILITIES:** (500 Series Category Code) Facilities providing for both in patient and out patient medical care. **EXAMPLES:** Hospital, Dental Clinic, Medical Laboratory, Morgue, Clinic Without Beds.
- ADMINISTRATIVE FACILITIES:** (600 Series Category Code) Headquarters and office type buildings to accommodate offices, professional and technical activities, business machines, records, files, and administrative supplies for normal operation. **EXAMPLES:** Post Headquarters Building, Division Headquarters Building, Provost Marshal & Military Police Administration Building, Civilian Personnel Administration Building, Engineer Administration Building.
- OPERATIONAL FACILITIES:** (110-169 Series Category Code) All facilities for housing operations and operational types of activities and equipment. Also includes airfield pavements, and waterfront operational facilities. **EXAMPLES:** Buildings for radio, radar, relay, and telephone operations; Liquid Fueling & Dispensing Facilities, Communications Center, Weather Station, Reception Station Processing Facility, Company Headquarters Building.
- STORAGE FACILITIES:** (400 Series Category Code) Facilities for receipt of bulktype storage. **EXAMPLES:** Liquid Fuel Storage Facilities, Ammunition Storage Facilities, Cold Storage Warehouse, Family Housing General Storage, Aircraft Parts Storage Building.
- UTILITY SYSTEMS:** (800 Series Category Code) Central plants, systems, buildings and exterior lines for the processing, generation, distribution, and disposal of utility related resources. **EXAMPLES:** Power Plant Building, Electrical Power Transmission & Distribution Lines, Sewage & Industrial Waste Collection, Incinerator Building, Water Supply-Treatment-Storage, Roads and Streets, Fire & Other Alarm Systems, Telephone System.
- M. W. R. FACILITIES:** (740-750 Series Category Code) Athletic, recreational and resale facilities. **EXAMPLES:** Bowling Center, Cafeteria, Library, Commissary, Child Care Facilities, Bank, Baseball Field, Golf Course.
- FAMILY HOUSING:** (711-714 Series Category Code) Buildings to be used as family quarters with appurtenant facilities. **EXAMPLES:** Family Housing & Trailer Sites for Officer, NCO, Enlisted, and Civilian Personnel.
- OTHER HOUSING:** (720-725 Series Category Code) Public housing for unaccompanied personnel with appurtenant facilities. **EXAMPLES:** Barracks & Dormitories for Unaccompanied Offices and Enlisted Personnel, Unaccompanied Personnel Housing Dining Facilities, Troop Housing Emergency.
- R & D FACILITIES:** (300 Series Category Code) Buildings used directly in theoretical or applied research, development, and testing, operations related to basic research. **EXAMPLES:** R & D Science Laboratories, R & D Aircraft & Flight Equipment Facility, R & D Weapons & Weapon Systems Facility, R & D Communications Equipment Facility.

REFERENCE OF FACILITY CHARACTERISTICS

- QUANTITY/ AMOUNT:** The gross square feet of a particular facility type, or the total land area of an installation's ranges and training grounds.
- FUNCTIONAL ADEQUACY:** On average, how well a facility type addresses the needs of its users.
- PHYSICAL CONDITION:** On average, the state of repair of a particular facility type.
- MANAGEABILITY:** On average, the level of expenditures required to maintain a particular facility type at acceptable standards over time.
- FLEXIBILITY:** On average, how well a particular facility type can adapt to changing requirements over time.
- APPEARANCE:** On average, the aesthetic quality of a particular facility type.
- LOCATION/ PROXIMITY:** On average, the geographic relationship of a particular facility type to other installation facilities.

**APPENDIX B: Extracts from the *President's Budget to Congress*
for *Military Construction (FY91)***

FY 1991 MILITARY CONSTRUCTION PROJECT DATA

1. Component: Army
2. Installation and Location: Fort Irwin, CA
3. Project Title: Hardstand/Tactical Equipment Shop

Description of Proposed Construction

Construct an organizational and direct support tactical equipment shop with 10-ton crane, dispatch office, oil house, a fuel dispensing point with tanks, maintenance platforms and hardstands. Supporting facilities include utilities, electric service, paving, walks, curbs and gutters, information systems, and site improvements. Heating will be provided by a self-contained system. Evaporative cooling: 26,000 cubic feet per minute (CFM). The high cost of the supporting facility results from the U.S. Army Information Systems Command (USAISC) requirement to provide information systems to this facility from the closest manhole connection 3600 feet from the project. Extensions of the water, sewer, and electrical utilities are longer than normal as we are building utilities as we need them project by project and only what is absolutely necessary.

Impact If Not Provided

If this project is not provided, the 87th Engineer Company will not have an adequate and functional facility to perform maintenance and repair to their vehicles and will not be able to effectively perform their mission in support of the NTC. The 87th Engineer Company troops are in the field approximately 238 days annually performing their mission. Nonavailability of equipment due to maintenance must be held to a minimum in order to provide realistic and effective support to the NTC. Without this project, engineer maintenance will continue to be performed on a dusty, sandy area in the desert because the installation has no facility. Additionally, environmental problems are great, and troop morale suffers due to having to perform maintenance operations in a hot and dusty environment.

FY 1991 MILITARY CONSTRUCTION PROJECT DATA

1. Component: Army
2. Installation and Location: Fort Rucker, AL
3. Project Title: Flight Simulator Building

Description of Proposed Construction

Construct a facility to house Army Aviation Combined Arms Tactical Trainer (AVCATT) flight simulator system. Connection to the energy monitoring and control system (EMCS). Supporting facilities include utilities, electric service, information systems, walks, fencing, curbs and gutters, security lighting, fire protection and alarm systems, storm drainage, parking, and site improvements. Heating will be provided by the central gas-fired plant. Air conditioning (125 tons) will be provided by a self-contained system. Demolish two temporary buildings (5000 SF). Support facility costs are high due to site improvements required at the project location.

Impact If Not Provided

If this project is not provided, aviation training will continue to be hampered by limited resources, safety and environmental constraints, and rising costs. The new trainer cannot be delivered until the proposed building has been completed. Only limited training will be accomplished without the AVCATT. It will be expensive in terms of all resources required, e.g. costs, training area usage, aircraft, and pilots.

FY 1991 MILITARY CONSTRUCTION PROJECT DATA

1. Component: Army
2. Installation and Location: Pine Bluff Arsenal, AR
3. Project Title: Detection Paper Facility

Description of Proposed Construction

Construct a paper manufacturing, impregnating, and processing plant. Supporting facilities include utilities, electric service, information systems, waste holding tank, fire protection and alarm systems, paving, apron, walks, storm drainage, security fencing and lighting, and site improvements. Heat will be provided from the self-contained boiler plant. Air conditioning (3 tons) will be provided by a self-contained unit. Mechanical ventilation: 16,000 CFM.

Impact If Not Provided

If this project is not provided, inadequate production now available cannot maintain current stockage levels. Existing stocks will exceed useful shelf life without replacement. Unavailability of detection paper will increase vulnerability of soldiers to chemical attack, with potential significant increase in numbers and severity of chemical casualties thus affecting mission accomplishment.

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V Corps
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29th Area Support Group
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100th Support Group
ATTN: AETT-EN-DEH 09114

2224 Base Battalion
ATTN: AETV-BHR-E 09034

235th Base Support Battalion
ATTN: Unit 28614 Amstach 09177

2934 Base Support Battalion
ATTN: ABUSG-MA-AST-WO-E 09086

409th Support Battalion (Base)
ATTN: AETTG-DEH 09114

412th Base Support Battalion 09630
ATTN: Unit 31401

Frankfurt Base Support Battalion
ATTN: Unit 25727 09242

CMTC Hohenfels 09173
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Mainz Germany 09185
ATTN: BSB-MZ-E

21st Support Command
ATTN: DEH (10)

US Army Berlin
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ATTN: AEBA-EN 09235

SETAP
ATTN: AESE-EN-D 09613
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Supreme Allied Command
ATTN: ACSOEB 09703
ATTN: SHIBBENGR 09705

INSCOM

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HQ XVIII Airborne Corps

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4th Infantry Div (MECH)

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Fort Pickett 23824
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Tobyhanna Army Depot 18466
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US Army Materiel Command (AMC)

Redstone Arsenal 35809
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Jefferson Proving Ground 47250
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Letterkenny Army Depot
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Pueblo Army Depot 81008
ATTN: SDSTE-PUL-F

Dugway Proving Ground 84022
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Tooele Army Depot 84074
ATTN: SDSTE-ELF

Yuma Proving Ground 85365
ATTN: STEYP-EH-E

Tobyhanna Army Depot 18466
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Sonoma Army Depot 14541
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Aberdeen Proving Ground
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Sharpe Army Depot 95331
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Savanna Army Depot 61074
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FORSCOM

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Fort Campbell 42223

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Fort McCoy 54656

ATTN: AFZR-DE
Fort Stewart 31314

ATTN: AFZP-DEF
Pi Buchanan 00934

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Pi Devens 01433

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Fort Drum 13602

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Fort Irwin 92310

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Fort Hood 76344

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ATTN: APVR-WF-DE 99703

National Guard Bureau 20310
ATTN: Installations Div

Fort Belvoir

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ATTN: CECC-R 22060
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ATTN: DRDNA-F

TRADOC

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Carlisle Barracks 17013

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Fort Eustis 23604

ATTN: DEH
Fort Chaffee 72905

ATTN: ATZR-ZF
Fort Sill 73503

ATTN: ATZR-E

US Army Materiel Tech Lab
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Arnold Air Force Station, TN 37389

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AMMRC 02172
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ATTN: AMSMC-IR 61299

ATTN: Facilities Engr (3) 85613

USAARMC

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Defense Logistics Agency

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ATTN: Geography & Envir Engrs

416th Engineer Command

ATTN: Gibson USAR Ctr

USA Japan (USARJ)

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ATTN: HONSHU 96343
ATTN: DEH-Okinawa 96376

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ATTN: Naval Civil Engr Laboratory (3) 93043

8th US Army Korea

ATTN: DEH (12)

US Army HSC

Fort Sam Houston 78234
ATTN: HSLO-F
Fitzsimons Army Medical Ctr
ATTN: HSHG-DEH 80045

Tyndall AFB

ATTN: AFESC Program Ofc
ATTN: Engrg & Srvc Lab

Chanute AFB

ATTN: 3345 CES/DE

USA TSARCOM

ATTN: STSAS-F

American Public Works Assoc.

ATTN: 60637

US Army Envir Hygiene Agency

ATTN: HSHB-ME 21010

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Nat'l Institute of Standards & Tech

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